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DRC, 2TIE

Vertical lines in left margin identify changed content.

WELDING, CARBON, LOW-ALLOY, AND CORROSION-RESISTANT STEELS (U)

Drawing Callout: Weld and Inspect per 9912119-01, Class (1),
(2), (3).

- (1) Specify applicable class of weld from 1.1.
- (2) Specify welding rods or electrodes per applicable material specification.
- (3) Supplemental notes may be required (see 6.1).

CHANGE HISTORY

<u>CONTROL NUMBER</u>	<u>ISSUE</u>	<u>RELEASE/CHANGE NO.</u>	<u>DATE</u>
9912119-01	F	922526KC; 921624SA	1/93
	G	990053KC	1/99

1. GENERAL.

1.1 Scope. This standard covers the requirements for process control, inspection, and acceptance of Class I and Class II arc welds in carbon and low-alloy steels and corrosion-resistant steels.

Class I -- A weld which is considered critical and, for higher reliability, has comprehensive inspection and nondestructive testing. See 4.4.2.1.

Class II -- A weld which has less stringent limits on imperfections and has less comprehensive inspection and nondestructive testing. See 4.4.2.2.

1.2 Definitions.

1.2.1 Welding Terms and Definitions. Welding terms and definitions used in this standard shall be in accordance with AWS A3.0 except as follows:

Porosity -- Approximately spherical-shaped voids in the metal.

Aligned Porosity -- Four or more individual voids within a specified weld length whose radiographic images are intersected by a straight line.

1.2.2 Welding Symbols. Welding symbols used on the product drawings shall be in accordance with ANSI/AWS A2.4.

1.2.3 Pentagon M Definition. **/M/** is a symbol placed adjacent to a section or paragraph to designate requirements or information pertinent only to Allied-Signal, Kansas City Division, its suppliers and subcontractors.

1.2.4 **/M/** Essential Process Variables. A welding condition which, when changed, will affect the mechanical or chemical properties (other than notch toughness) of the weldment.

2. DOCUMENTS.

2.1 Required. The following documents are requirements to the extent stated elsewhere in this standard:

/M/	9921006	Inspection, Penetrant
/M/	9948013	Inspection, Radiographic
/M/	9948018	Inspection, Magnetic Particle
	ASTM-E1417	Standard Practice for Liquid Penetrant Examination
	ASTM-E1444	Standard Practice for Magnetic Particle Examination
	ASTM-E1742	Standard Practice for Radiographic Examination
	AMS-STD-1595	Qualification of Aircraft, Missile and Aerospace Fusion Welders
	ANSI/AWS A2.4	Symbols For Welding and Nondestructive Testing
	ANSI/AWS A3.0	Welding Terms and Definitions
	ANSI/AWS B2.1	Standard for Welding Procedure and Performance Qualification
	ANSI/ASME Boiler and Pressure Vessel Code, Section VIII, Division 1	Pressure Vessels
	ANSI/ASME Boiler and Pressure Vessel Code, Section IX	Welding and Brazing Qualifications

3. REQUIREMENTS.

3.1 Welding Process. Welding shall be done by any of the arc welding processes, using manual, semiautomatic, and automatic techniques. When multiple choice of welding processes is given on a drawing, it shall be the responsibility of the fabricator to determine which process is appropriate for the specific weldment concerned.

3.2 Qualification of Welders and Welding Operators. Welders and Welding Operators shall be qualified in accordance with one of the following:

- (1) AMS-STD-1595.
- (2) ANSI/ASME Boiler and Pressure Vessel Code, Section IX.
- (3) ANSI/AWS B2.1.

3.2.2 Deleted.

3.3 Qualification of Welding Procedure.

3.3.1 The welding procedure for all Class I welds shall be qualified, and for those Class II welds for which the drawing requires qualification of procedure.

/M/ See 3.3.2.c for additional welding procedure requirements.

3.3.2 Welding procedure shall be qualified before welding is conducted on weldments for delivery, and shall consist of:

- a. Making sample welds on test parts which are made from base metal and filler metal meeting drawing requirements for weldments for delivery and which represent the thickness and design characteristics of welds in weldment for delivery. All aspects of welding practice appropriate for use on weldments for delivery, such as inert gas backup, back chipping or grinding root passes, preheat, current settings, etc., as applicable shall be documented.

3.3.2 Continued.

- b. Inspecting sample welds using methods specified on the drawing and/or herein, and by sectioning in an adequate number of places, to ensure that welds meet applicable quality requirements.
- c. On the basis of a. and b. above, establish written procedures for all welds present in the weldment for delivery. These procedures shall be followed in fabricating weldments for delivery.

/M/

For all welds, regardless of class and qualification applicability, a welding procedure consisting of detailed methods and essential process variables as determined by engineering shall be included in the manufacturing work directions.

- d. All welding procedures and qualification inspection data shall be recorded and kept on file by the welding fabricator and shall be available to the Buyer.
- e. When so specified, the welding procedure shall be subject to Sandia approval prior to welding on parts intended for delivery.

3.4 Weld Preparation. Loose scale, slag, rust, grease, oil, and other foreign matter shall be removed from surfaces to be welded.

3.4.1 Carbon and Low-Alloy Steels. Beveling and weld preparation may be done by oxygen cutting, provided cracking does not occur in the metal.

3.4.2 Corrosion-Resistant Steels. Beveling and weld preparation may be done by flux-oxygen cutting, provided cracking does not occur in the metal and provided at least 1/8 inch of metal is removed from all cut edges by mechanical means, grinding, etc.

- 3.5 Preheat.
- 3.5.1 Carbon and Low-Alloy Steels. Low-alloy steel having a carbon content greater than 0.25% and carbon steels having a carbon content greater than 0.35% shall be preheated to and maintained at a minimum temperature of 350°F during welding.
- 3.5.2 Corrosion-Resistant Steels. Hardenable steels of the 400 series shall be preheated to avoid cracking.
- 3.6 Low Hydrogen Covered Electrodes (EXX15, EXX16, EXX18 or EXX28). To prevent cracking in welds, low hydrogen flux-covered electrodes shall be stored and used in accordance with the recommendations of the electrode manufacturer and the electrode material specification.
- 3.7 Weld Defects. Imperfections that exceed the limits specified in Table 1 shall be considered defects and are unacceptable.

TABLE 1 - LIMITS OF IMPERFECTIONS IN ACCEPTABLE WELDS

Imperfection	Limit	
	Class I Weld	Class II Weld
Cracks in weld bead	Unacceptable	Unacceptable
Cracks in parent metal	Unacceptable	Unacceptable
Crater cracks	Unacceptable	Unacceptable
Incomplete fusion and inadequate joint penetration	Unacceptable	As determined by inspection methods for Class II welds, the aggregate length of the imperfections shall not exceed 1-1/2 T in a weld length of 6 T and the length of any individual imperfection shall not exceed 1/2 T. If the weld length is less than 6 T, the aggregate length of the imperfections shall not exceed 1/4 the weld length and the length of any individual imperfection shall not exceed 1/12 the weld length. (see Note 1)
Surface Porosity and Inclusions	<p>Individual size shall not exceed 1/32 inch or 1/4 T, whichever is less.</p> <p>Spacing shall not be less than 8 times the size of the larger adjacent imperfection.</p> <p>Aggregate length in any 3 inches of weld shall not exceed 1/8 inch or 1 T, whichever is less. (see Note 1)</p>	<p>Individual size shall not exceed 1/16 inch or 1/2 T, whichever is less.</p> <p>Spacing shall not be less than 4 times the size of the larger adjacent imperfection.</p> <p>Aggregate length in any 3 inches of weld shall not exceed 1/4 inch or 2 T, whichever is less. (see Note 1)</p>

TABLE 1 - LIMITS OF IMPERFECTIONS IN ACCEPTABLE WELDS
(Continued)

Imperfection	Limit	
	Class I Weld	Class II Weld
Internal Porosity	The maximum size and population of porosity shall be in accordance with Appendix IV of Section VIII Division 1, of ASME Boiler and Pressure Vessel Code.	Internal porosity is not normally detected by inspection methods for Class II welds and, therefore, is not a factor in their acceptability.
Internal Inclusions	Approximately spherical inclusions shall be evaluated as porosity. Any elongated inclusion which has a length greater than $1/4 T$ or $1/4$ inch, whichever is less, shall be unacceptable. Any group of inclusions in line shall not have an aggregate length greater than T in a length of $12 T$, except when the distance between successive inclusions exceeds $6 L$ (where L is the length of the longest inclusions in the group). (see Note 1)	Internal inclusions are not normally detected by inspection methods for Class II welds and, therefore, are not a factor in their acceptability.
Undercut	Unacceptable	Unacceptable (see Note 2)
Overlap	Unacceptable	Unacceptable (see Note 2)
Convexity of butt welds on either side	<u>Weld Size</u> Up to 0.125 inch 0.125 to 0.500 inch 0.500 inch and larger	<u>Maximum Reinforcement Height</u> 0.050 inch 25% of weld size 0.125 inch
Concavity	Unacceptable in butt welds. In fillet welds, actual throat shall not be less than the theoretical throat for specified weld size.	
Size of fillet welds	Specified weld size (length of legs) +50%, -0%	

- NOTES:
1. (T) is the specified minimum weld size.
 2. Infrequent undercut and overlap may be acceptable.

3.8 Repair of Defects. Repair of defects is permissible, if the repaired weldment, the repair weld itself, and the adjacent parent metal meet the requirements of the original weldment. Weldments that are heat treated after welding may be repair-welded only after reduction to a strength level lower than 125,000 psi tensile ultimate, and provided that heat treatment follows repairing. A repaired weldment shall be reinspected in the same manner as the original weldment.

3.9 Marking. Impression stamping and other marking methods that may degrade the weldment shall be used only when permitted and then only in the area designated by the product drawing.

4. QUALITY ASSURANCE PROVISIONS.

4.1 Lot Definition. A lot shall consist of all weldments of one design submitted for inspection at one time.

4.2 Responsibility for Inspection and Testing. Inspection and testing specified herein and on the product drawing shall be the responsibility of the supplier.

4.3 Inspection Sequence. Weldments shall be inspected after any heat treatment and after any cleaning or other preparation required for proper inspection.

4.4 Inspection and Testing Requirements.

4.4.1 In-Process Inspection. In-process inspection shall be performed to verify conformance to the weld preparation requirements in 3.4 and the preheat requirements of 3.5.

4.4.2 Product Inspection and Testing.

4.4.2.1 Class I Welds. The inspection requirements for Class I welds shall be:

- (1) 100% visual inspection,
- (2) 100% penetrant or magnetic particle inspection, and
- (3) 100% radiographic inspection.

4.4.2.2 Class II Welds. The inspection requirements for Class II welds shall be:

- (1) 100% visual inspection.
- (2) Penetrant or magnetic particle inspection of a 10% sample of each lot of weldments but never fewer than one weldment per lot. The sample shall be selected at random. If any weldment in the sample is found defective, the lot shall be rejected. Weldments of a rejected lot may be individually accepted by 100% penetrant inspection.

NOTE: Table 1 limits imperfections in Class II welds, and, therefore, describes the quality of the weld regardless of the fact that the required visual and penetrant inspection may not detect internal defects.

4.4.2.3 Class I and Class II Welds. Under the referee circumstances, the Production Agency reserves the right to require removal of a portion of any doubtful weld for testing or metallurgical examination. This portion can be removed by trepanning or other suitable method.

4.5 Inspection and Testing Methods.

4.5.1 Visual Inspection. Visual examination of welds and adjacent parent metal may be with the aid of magnification not exceeding 10X.

4.5.2 Penetrant, Magnetic Particle and Radiographic Inspection. Penetrant inspection shall be in accordance with ASTM-E1417 or 9921006. Magnetic particle inspection shall be in accordance with ASTM-E1444 or 9948018. Radiographic inspection shall be in accordance with ASTM-E1742 or 9948013, Quality Level 2.

4.6 Inspection Records. The supplier shall maintain the inspection records for at least one year after completion of welding.

5. /M/ PACKAGING, HANDLING AND STORAGE.

Not applicable.

6. NOTES.

6.1 Design Guidance.

6.1.1 Class I Weld Restrictions. Avoid specifying Class I welds for fillet welds and groove welds that do not require complete joint penetration.

6.1.2 Machining After Welding. Machining after welding that substantially reduces the thickness of the weld may result in a wider heat-affected zone and lower mechanical properties than assumed. For critical applications, consider limiting the extent of machining after welding.

6.1.3 Post-Weld Heat Treatment. Post-weld heat treatment, when required, should be specified on the product drawing.

6.1.4 Repair of Welds. Repair welding may result in a wider heat-affected zone and lower mechanical properties than assumed. For critical application, consider limiting the extent of repairs.

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